

King County Department of Natural Resources and Parks

**CARNATION WASTEWATER TREATMENT FACILITY**

**FINAL FACILITIES PLAN**

**TABLE OF CONTENTS**

	<u>Page</u>
ACRONYMS AND ABBREVIATIONS.....	viii
1.0 EXECUTIVE SUMMARY .....	1-2
1.1 Future Flows and Loads.....	1-4
1.2 Water Quality and Regulatory Approvals .....	1-5
1.3 Treatment Process .....	1-7
1.4 Wastewater Treatment Facility Siting.....	1-8
1.5 Discharge Alternatives .....	1-9
1.6 Recommendation and Costs .....	1-12
2.0 PURPOSE AND SCOPE .....	2-1
2.1 Purpose .....	2-1
2.2 Background .....	2-1
2.3 Previous Wastewater Studies .....	2-1
2.4 City of Carnation – King County Partnership.....	2-6
2.5 Study Area.....	2-6
2.6 Selection of Siting Alternatives .....	2-7
2.7 Planning Period .....	2-9
2.8 No Action Alternative Impact .....	2-10
2.9 Project Chronology .....	2-12
3.0 EXISTING ENVIRONMENT .....	3-1
3.1 Population .....	3-1
3.2 Existing Wastewater Collection and Treatment Facilities.....	3-1
3.2.1 City of Carnation .....	3-1
3.2.2 Surrounding Cities .....	3-2
3.3 Surrounding Environmental Sensitivity.....	3-2
3.3.1 Special-Status Plant and Wildlife Species .....	3-2
3.3.2 Floodplains and Floodways .....	3-3
3.3.3 Wetlands .....	3-5
3.4 Potable Water.....	3-6
3.5 Hydrogeology .....	3-6
3.6 Surface Water .....	3-8
3.6.1 Snoqualmie River .....	3-8
3.6.2 Tolt River .....	3-9
3.6.3 Harris Creek.....	3-10
3.7 Soils.....	3-10
3.8 Land Use and Shoreline Areas .....	3-12
3.9 Air Quality .....	3-13
3.10 Historic and Archaeological Sites .....	3-13

King County Department of Natural Resources and Parks

**CARNATION WASTEWATER TREATMENT FACILITY**

**FINAL FACILITIES PLAN**

**TABLE OF CONTENTS**  
**(CONTINUED)**

	<u>Page</u>
4.0 DISCHARGE STANDARDS .....	4-1
4.1 Discharge Alternatives .....	4-1
4.1.1 Direct Discharge to the Snoqualmie River.....	4-4
4.1.2 Wetland Discharge .....	4-7
4.1.3 Upland Discharge .....	4-8
4.1.4 Water Reuse.....	4-9
4.2 Influent and Effluent Quality .....	4-9
4.3 Emerging Pollutants of Concern.....	4-10
5.0 FUTURE CONDITIONS .....	5-1
5.1 Population Development .....	5-1
5.2 Flow Development Methodology .....	5-2
5.2.1 Average Annual Flow.....	5-2
5.2.2 Inflow and Infiltration.....	5-3
5.2.3 Peaking Factors.....	5-5
5.3 Wastewater Design Loads .....	5-6
6.0 PRELIMINARY DEVELOPMENT OF PRINCIPAL ALTERNATIVES .....	6-1
6.1 Vacuum-Based Sewer Collection System .....	6-1
6.2 Wastewater Treatment Facility.....	6-1
6.2.1 Site Alternatives.....	6-1
6.2.2 Discharge Alternatives.....	6-2
6.2.3 Conveyance Route Alternatives for Treatment Facility Discharge .....	6-12
6.3 Liquid Treatment Process Evaluation.....	6-15
6.3.1 Initial Selection Methodology .....	6-16
6.3.2 Preliminary Treatment .....	6-17
6.3.3 Primary Treatment.....	6-17
6.3.4 Secondary Treatment .....	6-18
6.3.5 Tertiary Treatment .....	6-21
6.3.6 Disinfection .....	6-21
6.4 Solids Handling .....	6-22
6.4.1 Headworks Residuals.....	6-23
6.4.2 Handling of Wasted Solids.....	6-23
6.5 Odor Control.....	6-25
6.5.1 Methodology .....	6-25
6.5.2 Odor Handling Strategies .....	6-26
6.6 Overall Cost Estimate Evaluation Criteria .....	6-27
6.6.1 Cost Estimating Strategy .....	6-27
6.6.2 Treatment Facility Costs .....	6-28
6.6.3 Conveyance and Discharge Costs .....	6-31

King County Department of Natural Resources and Parks

**CARNATION WASTEWATER TREATMENT FACILITY**

**FINAL FACILITIES PLAN**

**TABLE OF CONTENTS**  
**(CONTINUED)**

	<u>Page</u>
7.0 FINAL RECOMMENDED ALTERNATIVE .....	7-1
7.1 Recommended Treatment Facility Site .....	7-1
7.2 Recommended Discharge Location .....	7-3
7.2.1 Tolt MacDonald Park .....	7-10
7.2.2 Carnation Farm Road Bridge.....	7-10
7.2.3 Cost Comparison.....	7-13
7.2.4 Conclusion .....	7-13
7.3 Recommended Conveyance Route .....	7-14
7.4 Recommended Wastewater Treatment Design .....	7-15
7.4.1 Discharge Requirements .....	7-15
7.4.2 Influent.....	7-21
7.4.3 Headworks.....	7-22
7.4.4 Biological Treatment and Disinfection .....	7-24
7.4.5 Solids Handling.....	7-30
7.4.6 Odor Control .....	7-31
7.4.7 Support Facilities .....	7-32
7.4.8 Staffing Requirements .....	7-34
7.5 Hydraulic Analysis .....	7-34
7.6 Conservation by Water Demand Management .....	7-37
7.7 Reliability and Redundancy.....	7-42
7.8 Final Planning Cost Estimate .....	7-43
7.9 Future Expansion .....	7-47
8.0 FINANCIAL ANALYSIS .....	8-1
8.1 Capital Cost Allocation .....	8-1
8.2 Operations and Maintenance Cost Allocation .....	8-1
8.2.1 Period of Analysis .....	8-2
8.2.2 Operations Labor Rate .....	8-2
8.2.3 Power Cost .....	8-3
8.2.4 Chemical Cost .....	8-3
8.2.5 Maintenance Cost.....	8-3
8.2.6 Solids Transportation Cost .....	8-3
8.3 Project Financing.....	8-3
8.3.1 Project Financing.....	8-3
8.3.2 Customer Charges.....	8-4

King County Department of Natural Resources and Parks

**CARNATION WASTEWATER TREATMENT FACILITY**

**FINAL FACILITIES PLAN**

**TABLE OF CONTENTS**  
**(CONTINUED)**

	<u>Page</u>
9.0 PROJECT IMPLEMENTATION .....	9-1
9.1 Schedule .....	9-1
9.1.1 Construction Sequence .....	9-1
9.1.2 Public Involvement.....	9-2
9.2 Permitting and Regulatory Approvals.....	9-4
9.2.1 Water Quality Plan Compliance.....	9-4
9.2.2 Biological Assessment.....	9-4
9.2.3 Joint Aquatic Resources Permit Application .....	9-4
9.2.4 Environmental Impact Statement.....	9-5
9.2.5 Environmental Assessment .....	9-5
9.2.6 Other Construction and Discharge Permits .....	9-5

**LIST OF APPENDICES**

- APPENDIX A – City of Carnation 2004 Comprehensive Sewer Plan, Executive Summary
- APPENDIX B – City of Carnation 2004 Draft Sewer Facilities Plan, Executive Summary
- APPENDIX C – King County - City of Carnation Agreement for Sewage Disposal
- APPENDIX D – Severe Public Health Hazard in the City of Carnation Letter
- APPENDIX E – City of Carnation Water Reuse Interest Letter
- APPENDIX F – Preliminary Cost Comparison
- APPENDIX G – Salmonid Use of the Snoqualmie River - Tolt Delta Reach
- APPENDIX H – Discharge *Hydraulix™*
- APPENDIX I – Reliability Checklist and Water Quality Comparison
- APPENDIX J – Conveyance Cost Estimate Support
- APPENDIX K – Alternate WWTF Cost Estimate (discharge to SWA)
- APPENDIX L – Public Involvement Chronology

**CARNATION WASTEWATER TREATMENT FACILITY****FINAL FACILITIES PLAN****TABLE OF CONTENTS  
(CONTINUED)**

	<u>Page</u>
<b><u>LIST OF TABLES</u></b>	
Table 1.1	Population, Flow, and Load Projections .....
Table 1.2	Anticipated Discharge Requirements to the Snoqualmie River.....
Table 1.3	Conceptual Level Cost Estimate .....
Table 2.1	Projected Population Growth Estimates.....
Table 2.2	Decision Process Milestones .....
Table 3.1	Historical Population Estimates.....
Table 3.2	Concentration Ranges for Samples Collected on the Snoqualmie and Tolt Rivers Near Carnation from February 2003 to January 2004 .....
Table 4.1	Estimated Maximum Allowable Discharge Limits (Months of August, September, and October).....
Table 4.2	Potential NPDES Permit for the Snoqualmie River .....
Table 5.1	Population Projections for the City .....
Table 5.2	Unit Rates for Wastewater Flow.....
Table 5.3	Comparisons of Peaking Factors .....
Table 5.4	Flow and Load Projections .....
Table 6.1	Evaluation of SBR and SBR-Type Processes.....
Table 6.2	Evaluation of Activated Sludge BNR Processes .....
Table 6.3	Evaluation of Activated Sludge BNR with MBR Process.....
Table 6.4	Comparison of Filtration Processes .....
Table 6.5	Preliminary Estimate of Headworks Residuals Volumes.....
Table 6.6	Estimate of Transported Solids Volumes .....
Table 6.7	Estimated Individual Minimum Odor Control Vent Rates .....
Table 6.8	Scenario Alternatives Present Worth Cost Comparison.....
Table 6.9	Solids-Handling Cost Comparison .....
Table 6.10	Scenario Process Comparison .....
Table 6.11	Conveyance and Discharge Alternative Cost Comparison .....
Table 7.1	Snoqualmie River Outfall Location Comparison.....
Table 7.2	Cost Comparison of Snoqualmie River Discharge Locations.....
Table 7.3	Conveyance Route Comparison .....
Table 7.4	Anticipated Discharge Requirements .....
Table 7.5	Influent Flow .....
Table 7.6	Design Influent Concentrations .....
Table 7.7	Headworks Design .....
Table 7.8	Treatment Design Criteria .....
Table 7.9	Solids Holding Basins.....
Table 7.10	Unit Water Consumption Rates for Water Conservation Scenarios .....
Table 7.11	Projected Average Annual Flow Rates for Water Conservation Scenarios .....
Table 7.12	Conservation Retrofit Project Study Findings .....
Table 7.13	Cost Impacts of Conservation Alternatives .....
Table 7.14	EPA Unit Process Component Reliability Requirements .....

King County Department of Natural Resources and Parks

**CARNATION WASTEWATER TREATMENT FACILITY**

**FINAL FACILITIES PLAN**

**TABLE OF CONTENTS**  
**(CONTINUED)**

	<u>Page</u>
Table 7.15 Conceptual Level Cost Estimate.....	7-44
Table 8.1 Total Capital Cost.....	8-1
Table 8.2 Operations and Maintenance Costs .....	8-2
Table 9.1 Project Schedule .....	9-1

**LIST OF FIGURES**

Figure 1.1 Project Study Areas in Carnation and Vicinity.....	1-3
Figure 1.2 Study Alternatives .....	1-10
Figure 2.1 Project Study Area in Carnation and Vicinity .....	2-2
Figure 2.2 Study Alternatives .....	2-8
Figure 3.1 Floodways and Floodplain.....	3-4
Figure 3.2 Critical Aquifer Recharge Areas .....	3-7
Figure 3.3 City Zoning Areas.....	3-14
Figure 3.4 King County Zoning and Shoreline Designations.....	3-15
Figure 3.5 Historic Structures and Properties.....	3-17
Figure 5.1 2002 City Potable Indoor/Non-Seasonal Water Use .....	5-4
Figure 6.1 Conceptual River Outfall Discharge .....	6-5
Figure 6.2 Conceptual Upland Discharge.....	6-7
Figure 6.3 Conceptual Wetland Discharge.....	6-10
Figure 7.1 Recommended WWTF Site Plan .....	7-2
Figure 7.2 Recommended Effluent Discharge System.....	7-4
Figure 7.3 WDFW Chinook Redd Observations .....	7-9
Figure 7.4 Snoqualmie River Profile Near Tolt MacDonald Park .....	7-11
Figure 7.5 River Profile and Outfall at Bridge .....	7-12
Figure 7.6 Snoqualmie River Outfall Conveyance Comparison .....	7-16
Figure 7.7 Preliminary Process Schematic.....	7-19
Figure 7.8 Hydraulic Profile .....	7-36